Chapter 3: Pipe Arch Culverts with Roughening Baffles 2

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For the purposes of this report the following definitions of baffles and weirs are proposed. Weirs and Baffles have different functions and design methodology for modeling ish passage.

A baffle is a vertical plate that is placed in a culvert or stream for the purpose of collecting substrate and providing low velocity areas.

A weir is a vertical or sloping plate with or without a notch that is placed in a culvert to create a backwater pool and provide low velocity areas.

The “active channel” is that portion of the stream channel that contains the average high monthly flow. On coastal streams in Oregon this width is normally free of grass and easily identified. On deeply cut draws the active channel width may not be easily determined the “active channel” width may need to be found by measuring widths on similar grades and stream type upstream or downstream.

Stream Simulation using Roughening Baffles

A pipe with the herringbone roughening baffles is designed to retain substrates thus creating a natural channel for movement of all species. The design method used is the stream simulation procedure. Small fish and aquatic species will move behind, between, and in the substrate that collect in the pipe finding protection and cover areas similar to a natural stream. For this design to work well the pipe should be the same width of the active channel of the stream.

Fish passage through pipes is obtained by having a natural substrate which add sufficient roughness to reduce velocity and eliminate any potential barrier.

The Herringbone Baffle Design

Pipes with herringbone baffles are constructed with vertical plates configured to collect the stream’s substrate. Numerous culverts have been constructed with this plan and monitored for effectiveness. The monitoring data is summarized in Appendix B of this manual.

The herringbone design eliminates barriers to fish passage by collecting substrate as a stream simulation design and alternately acting as a pool and weir fishway if the

substrate is washed out. The monitoring data indicated that substrate collects in the structure when the pipe is back -watered its entire length or if cobble size material is moving through the channel. Those sites that did not have either of those conditions did not retain substrates to the full height of the baffles.

We are getting excellent adult passage with this design even when full substrate collection is not achieved. The velocities measured in the pipe without a substrate are low indicating that juvenile passage is also possible.

Recommendations

1. This design is recommended for any site that is backwatered. Substrates will collect to the backwater point for stream simulation.

2. For culverts up to 5% grade this design will collect substrates if the stream is moving rocks in the cobble size range.

3. For culverts up to 5% when the natural substrate in the stream is less then cobble size. The culvert should be embedded with cobble size materials. We recommend doing this work over several years. During the first year install the culvert with the controls. If substrates do not collect naturally as desired then come back the second year and embedded the pipe. The pipe will not be a barrier to fish passage without substrates and leaving it for a year is a good way to monitor the design's performance. Embed the pipe with rock-sized in the cobble to boulder size range as noted in chapter two.

4. Culverts need to be as wide as the active channel width of the stream. On coastal streams in Oregon, Pipe arches designed for a Q100 at a Headwater to depth ratio of 0.75 will approximate the active channel width.

5. The pipes are self cleaning. We have not had to remove any debris from these pipes.

6. Circular culverts are not recommended for this design. An arch has greater width at the base and approximates the active channel width better than a circular pipe of the same size.

The direction of flow through the pipe is toward the apex of the herringbone V. As gravel enters the pipe they will turn into the notch. The baffles collect gravel beginning at the ends of their tappers and progressively toward the front. The first baffle is located approximately 2 feet from the entrance invert.

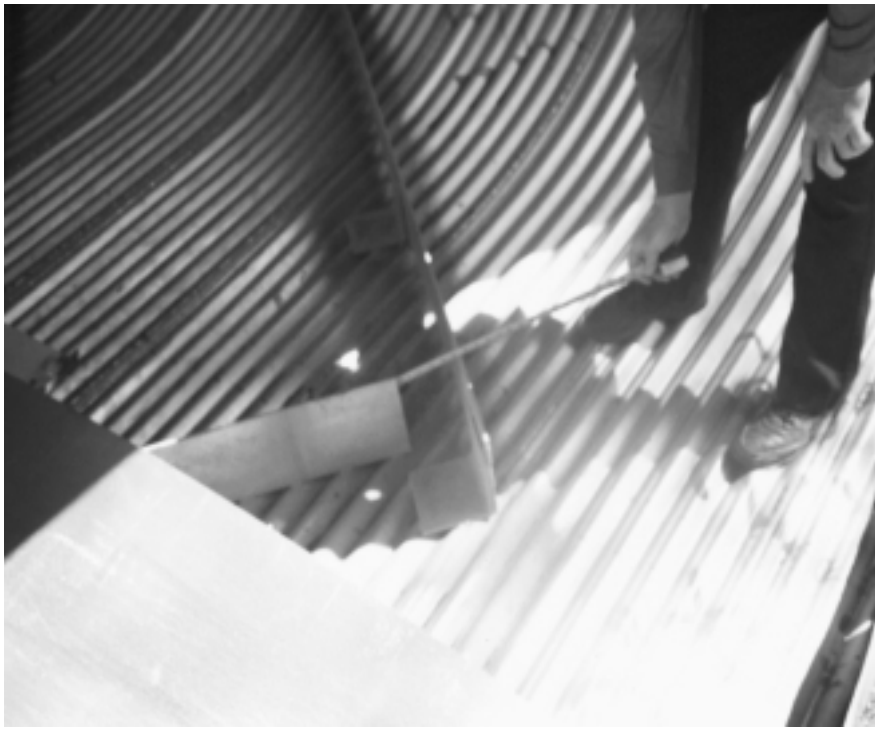
In pipe arch culverts the baffles are attached to brackets which are welded to the floor of the pipe. The brackets and baffles **must** be galvanized to protect the pipe from rapid oxidation. The baffles need not be continuously welded to the pipe as their purpose is to collect grave, not backwater flow. The baffles are spots welded at the top of the corrugations to the pipe. This leaves a gap between the corrugations and the baffle plates. This is assumed a better passage model than continuous welding and is also less expensive.

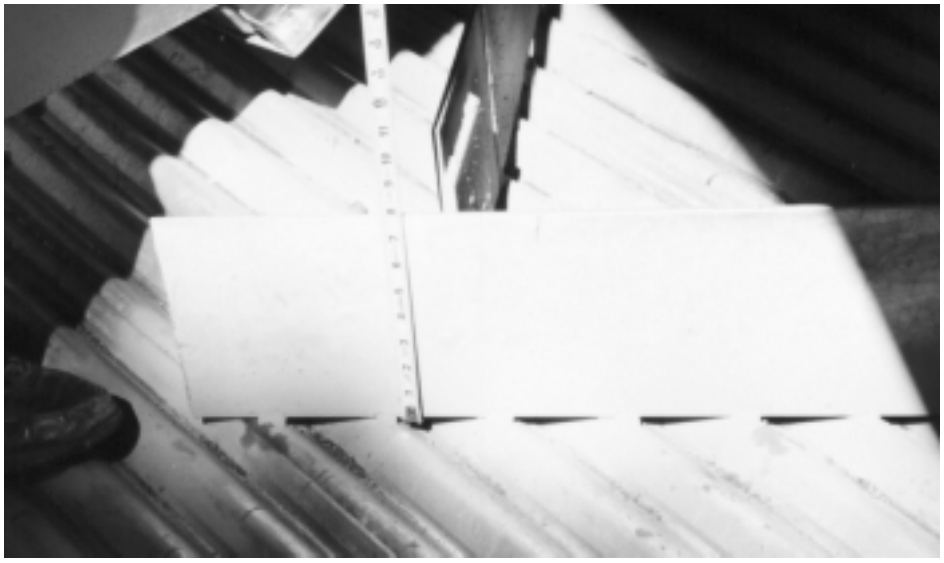
On multi-plate structures the brackets can be bolted to the floor of the pipe. This will require some additional fabrication time as the supplier must custom fabricate the baffles and brackets to match the proposed layout. Varying the angle of the baffles from 30 degrees to 45 degrees will simplify the design.

We attempt to leave a minimum spacing between the baffles and the culvert ends of two to three feet. Our concern is to have a backwater which will help collect gravels. On the outlet as part of the design a minimum of six inches of backwater is maintained by the control weir as discussed earlier. If in a bedrock outlet condition, substituting boulder weirs for a pool at the outlet would be an acceptable alternative.

The herringbone design begins at the inlet. The first baffle begins two feet from the inlet. Substrates should fill this gap and provide a smooth transition into the culvert. Designs with baffles further than two feet from the inlet take longer to fill with gravels and may leave a stretch of bare metal.

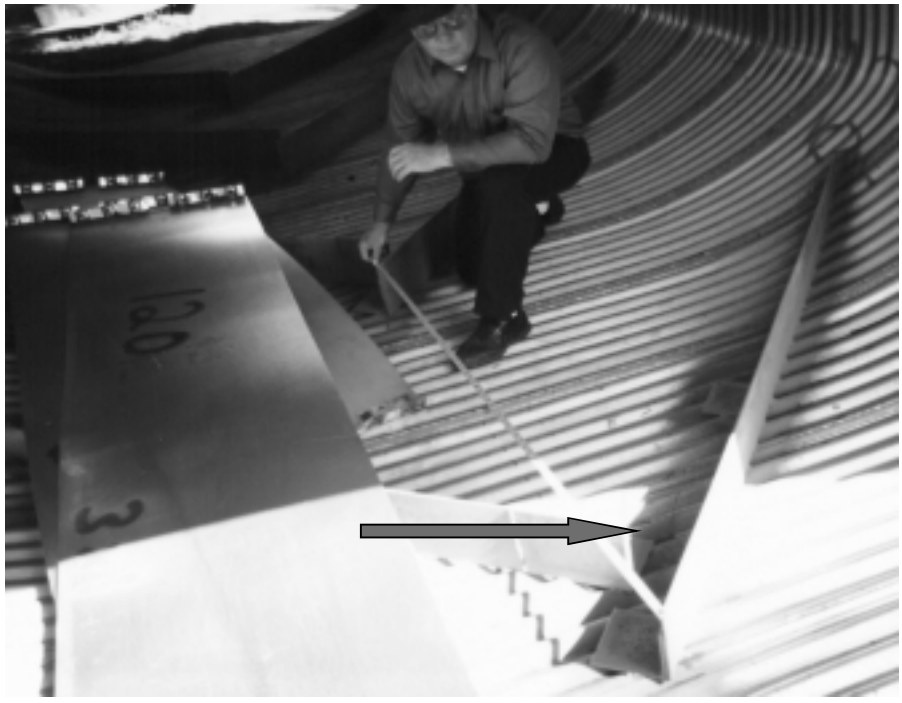
A six-inch gap is designed between the baffle sets.

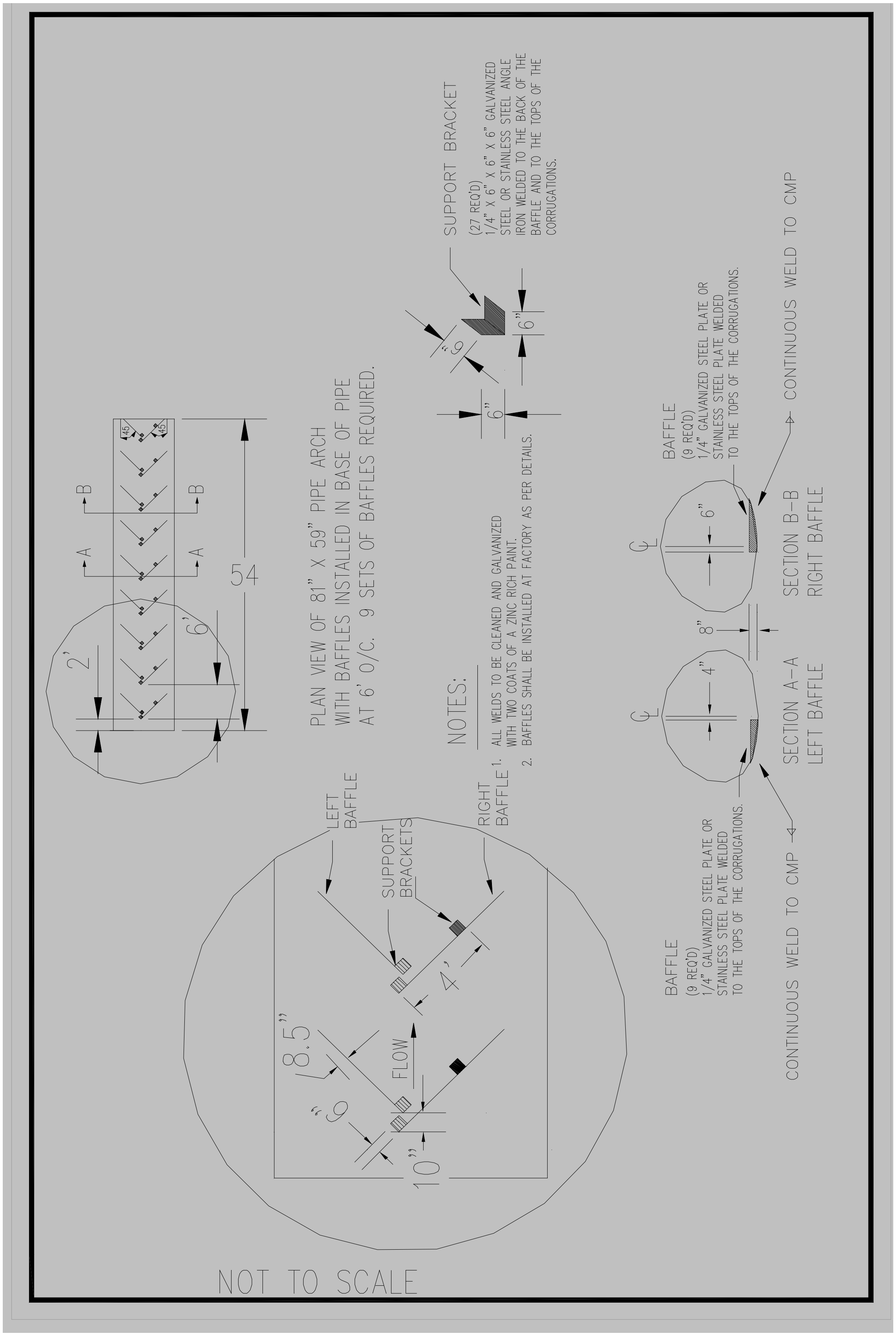




The height of the baffles is eight inches. The baffles are tapered to extend to the edges of the pipe when the pipe is horizontal. This gives this a slight downward tapper as grades increase.

The distance between baffles is 6-feet. The baffle plates are offset from the centerline of the pipe to give a meandering flow avoiding a continuous open slot for the full length of the culvert. See the arrow.




SUPPORT BRACKET
(27 REQ'D)
1/4" X 6" X 6" GALVANIZED STEEL OR STAINLESS STEEL ANGLE IRON WELDED TO THE BACK OF THE BAFFLE AND TO THE TOPS OF THE CORRUGATIONS.
6"
6"
6"
45
45
54
A
A
B
B
2'
6'
PLAN VIEW OF 81" X 59" PIPE ARCH WITH BAFFLES INSTALLED IN BASE OF PIPE AT 6' O/C. 9 SETS OF BAFFLES REQUIRED.
NOTES:
1. ALL WELDS TO BE CLEANED AND GALVANIZED WITH TWO COATS OF A ZINC RICH PAINT.
2. BAFFLES SHALL BE INSTALLED AT FACTORY AS PER DETAILS.
BAFFLE
(9 REQ'D)
1/4" GALVANIZED STEEL PLATE OR STAINLESS STEEL PLATE WELDED TO THE TOPS OF THE CORRUGATIONS.
CONTINUOUS WELD TO CMP
6"
8"
4"
SECTION B-B
RIGHT BAFFLE
SECTION A-A
LEFT BAFFLE
LEFT BAFFLE
RIGHT BAFFLE
SUPPORT BRACKETS
4'
8.5"
FLOW
6"
10"
BAFFLE
(9 REQ'D)
1/4" GALVANIZED STEEL PLATE OR STAINLESS STEEL PLATE WELDED TO THE TOPS OF THE CORRUGATIONS.
CONTINUOUS WELD TO CMP
NOT TO SCALE